Endovascular Treatment of a Dural Arteriovenous Fistula of the Transverse Sinus by Recanalisation, Angioplasty and Stent Deployment

A Case Report and Follow-up

W. WEBER, B. KIS*, J. ESSER**, P. BERLIT*, D. KÜHNE

Department of Radiology and Neuroradiology, Alfried Krupp Krankenhaus, Essen,
**Department of Neurology, Alfried Krupp Krankenhaus, Essen,*
***Department of Ophthalmology, University of Essen, Essen; Germany*

Key words: dural arteriovenous fistula, transverse sinus, angioplasty and stent

Summary

We report the endovascular treatment of a 40-year-old woman with bilaterally thrombosed transverse sinuses and a dural arteriovenous fistula (DAVF) causing cortical venous reflux by recanalization, angioplasty and stent deployment of the occluded sinus segment followed by occlusion of the DAVF by stent deployment in the fistulous segment. By recanalization of the occluded sinus we re-established normal anterograde venous drainage and eliminated the venous hypertension and cortical venous reflux. After the procedure, the patient was treated with aspirin and clopidogrel for three months. A follow-up examination showed total occlusion of the DAVF, patency of the sinus and a complete resolution of the clinical symptoms.

Introduction

Dural arteriovenous fistulas (DAVF) are abnormal arteriovenous shunts within the dura mater. Most of these lesions are located in the dural sinus, in our case on the transverse sinus. The risk of haemorrhage or non-haemorrhagic deficit depends on the pattern of venous drainage. There are numerous classification systems in the literature: the grading systems by the University of California at San Francisco [1], Cognard [2], Borden [3] or by Djindjian [4]. Here we describe a type III DAVF (according to the University of California at San Francisco grading system [1]), which shows retrograde cortical venous drainage, without antegrade flow through the normal venous pathways. In cases of such high grade fistula, the annual mortality rate is 10.4%. The annual risk for haemorrhagic morbidity is 8.1% and for non-haemorrhagic morbidity it is 6.9% [5]. The goal of treatment in high grade DAVF must be the elimination of the cortical venous reflux and venous hypertension, ideally with closure of the shunt.

The conventional endovascular therapeutic strategies in these high grade fistulae include either alone or in combination, embolization of the dural arterial feeders to reduce flow into the fistula and occlusion of the sinus in its fistulous part through a transvenous approach [6-8]. Treatment does not normally aim to re-open the occluded normal venous pathways. We decided that it might be important to recanalize the ipsilateral transverse sinus by balloon angioplasty and stent deployment to re-establish anterograde flow and eliminate venous hypertension in the sinus and cortical veins.

Case Report

This 40-year-old woman complained of intermittently blurred vision, vertigo and a pulsatile

tinnitus in the right ear for five months. When she was admitted to our hospital in November 2001, she reported a new continuous, dull rustling sound in the left ear. Aside from oral contraceptives for more than 20 years there were no regular medications. She stopped smoking five years ago. Her further medical and family history was unremarkable, particularly with regard to peripheral thrombosis. The neurological examination was normal. There was no audible bruit. A magnetic resonance (MR) brain scan which was done six weeks after onset of symptoms, showed thrombosis of the superior sagittal sinus and the left transverse sinus but no signs of intracranial haemorrhage or brain ischemia. An opthalmoscopic examination revealed bilateral chronic congestion of the papilla. The results of an extensive work-up for possible hypercoagulable states were negative. Oral anticoagulant therapy with phenprocoumon was initiated. MR imaging after two months showed a patent superior sagittal sinus but a persistent occlusion of the left transverse sinus and multiple dilated cortical veins. When the patient was admitted to our clinic, digital subtraction angiography was performed, demonstrating a DAVF located in the middle part of the right transverse sinus. The arterial supply was from the external carotid artery (middle meningeal artery), the internal carotid artery (cavernous segment) and the vertebral artery (posterior meningeal artery) (figure 1).

The distal segment of the right transverse sinus was occluded. The right jugular vein was patent up to the sigmoid sinus. The left transverse sinus was also occluded. Venous drainage was directed into the superior sagittal sinus with retrograde filling of cortical veins of both hemispheres. By the grading system of Cognard et Al[2] this is a Type II a+b fistula and by the grading system of the University of California at San Francisco[1] this is a Type III Fistula.

The intervention was performed under general anesthesia. A 6 French Brite-tip guiding catheter (Cordis Corporation, Miami, Fl, USA) was brought through the right femoral vein up to the right jugular bulb and a 4 French diagnostic catheter was placed from the left femoral artery into the right external carotid artery. A 0.035-inch guidewire (Terumo Corporation, Tokyo, Japan) was passed through the occluded part of the right transverse sinus. After passing the occluded segment, the Terumo guidewire was removed under roadmapping. A Rapid Transit microcatheter (Cordis Endovascular Systems, Miami, FL, USA) with a Choice-PT guidewire (Boston Scientific Corporation, Miami, FL, USA) was navigated through the same path as the Terumo 0.035-inch guidewire. The Choice-PT guidewire was left in place while the Rapid Transit microcatheter was removed. A Bypass-Speedy balloon-catheter (Boston Scientific Corporation, Natick, MA, USA, diameter: 4.5 mm) was passed over the Choice-PT wire and angioplasty was performed with gentle pressure in the transverse sinus proximal to the fistula. After removal of the Bypass-Speedy balloon catheter, a Cordis Velocity stent (Cordis Europe, Rode, The Netherlands, diameter: 5 mm) was navigated into the dilated segment and deployed with gentle pressure. Two further stents (diameters: 5 and 4.5 mm) were pushed through the first stent and deployed in the fistulous part of the transverse sinus. A small persistent arteriovenous shunt from the right middle meningeal artery into the transverse sinus was occluded by embolization with N-Butyl Cyanoacrylate from a distal point near the transverse sinus.

Final angiography at the conclusion of the procedure showed a small amount of contrast filling the fistula from internal carotid artery feeders only. In a second angiography five days after the treatment the fistula was occluded. The patient reported an immediate cessation of her ear sound after the endovascular treatment. When she was discharged from our hospital the oral anticoagulant therapy had been stopped and she was treated with a combination of aspirin and clopidogrel.

After three months, a follow-up angiogram was performed, confirming complete occlusion of the fistula, patency of the right transverse sinus and absence of a cortical venous drainage. There was no further evidence of the bilateral chronic congestion of the papilla in the ophthalmoscopic examination. The ear sound remained absent.

Discussion

The goals of mechanical recanalization of a thrombosed sinus by angioplasty and stent deployment are to re-open the normal venous pathways, eliminate venous hypertension and improve the associated clinical signs. Chaloup-

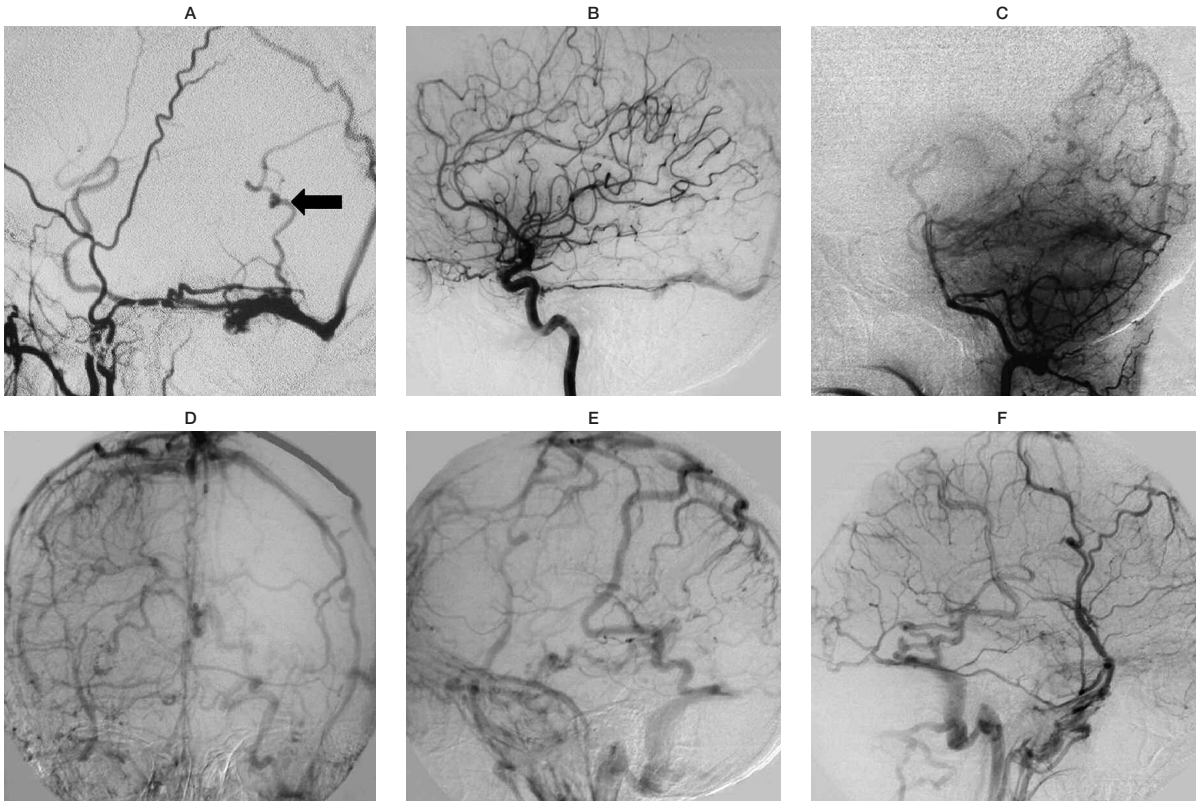

Figure 1 Pre-embolization angiography of the right external carotid artery (lateral view), the right internal carotid artery (lateral view) and the right vertebral artery (lateral view) demonstrating the supply to the feeders, retrograde filling of the superior sagittal sinus (A, B, C) and a cortical vein (A, see arrow.). Pre-embolization late venous angiography of the right internal carotid artery demonstrated the occlusion of both transverse sinuses, the retrograde flow in the hemisphereal cortical veins and the venous drainage of the Vein of Labbé into the patent part of the left transversus sinus (D, E).Due to the venous hypertension the superior sagittal sinus is not opacified after injection into the left internal carotid artery (F).

ka and colleagues [9] described a case of a mechanical thrombolysis via a microballoon percutaneous transluminal angioplasty for the treatment of an acute dural sinus thrombosis. This technique results in a more rapid restoration of venous flow after acute dural sinus thrombosis. Malek and colleagues [10] reported a case of stent deployment in an occluded occipital sinus in the case of dural fistulae in multiple locations of the sinus system. The fistulae was treated conventionally by arterial and transvenous approach. The occluded sinus was first treated by angioplasty and after recurrence of thrombosis by deploying a self-expanding Wallstent. The result of their procedure was similar to ours: the neurological symptoms improved immediately after the venous hypertension was eradicated. We describe the successful treatment of a high grade DAVF by stent deployment in the transverse sinus. The follow-up angiography and clinical examination after three months showed a stable result with complete occlusion of the fistula, eradication of the formerly retrograde filling cortical veins, patency of the ipsilateral transverse sinus and a complete improvement of the clinical symptoms.

We agree with Murphy [8], who reported the endovascular treatment of a high grade DAVF with a similar technique, that it may be important to compress dural septations within the arteriovenous shunts by stents. In our case, we were very anxious not to rupture the sinus. We therefore decided to inflate the ballon catheter with gentle pressure only. In addition, it was necessary to inject N-Butyl Cyanoacrylate into the middle meningeal artery to occlude the fistula completely. The conventional treatment of DAVF by coil occlusion of the transverse sinus at the fistulous segment would not necessarily eradicate the venous hypertension and was not feasible in this case because of the occlusion of

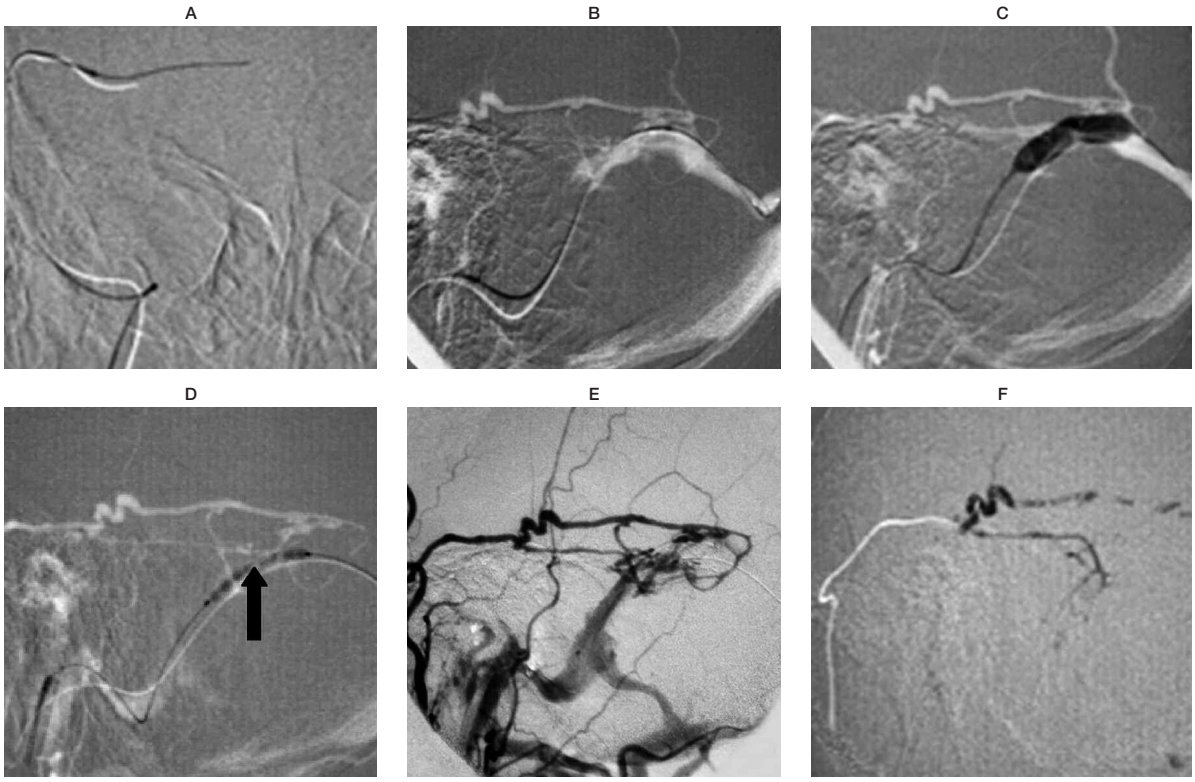

Figure 2 Position of the Rapid Transit microcatheter after passing the occluded segment of the right transverse sinus (A, B). Angioplasty of the transverse sinus (C). Position of the stent before deployment at the fistulous site (D, see arrow). Angiography of the right external carotid artery after stent deployment shows a slight filling of the fistula by the middle meningeal artery feeders (E). Glue injection into the middle meningeal artery (F).

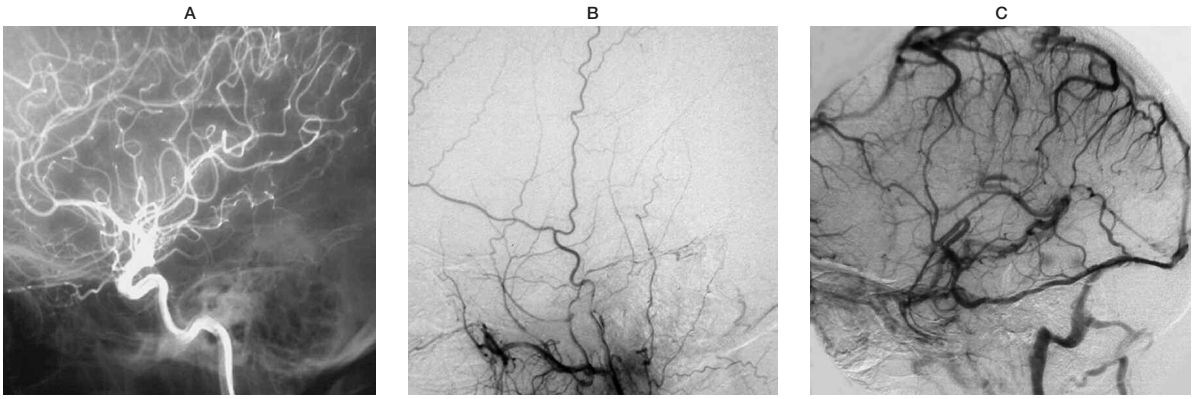

Figure 3 Angiography three months after the treatment demonstrated a normal result after injection into the right internal carotid artery (lateral view) and the right external carotid artery (lateral view) (A, B). Late venous angiography of the right internal carotid artery was also normal and showed patency of the right transverse sinus (C).

both transverse sinuses. The goal of our treatment strategy using venous stents was to re-establish as far as possible normal venous pathways. We believe that the stent deployment after balloon angioplasty was essential in the successful treatment of an occluded sinus because angioplasty alone is ineffective in the long-term. After angioplasty, the venous lumen often returns to the predilated diameter [10]. We observed this after an initial angioplasty. In our case, there was no detectable cortical drainage after re-opening of the ipsilateral transverse sinus. A high grade fistula was transformed into a low grade fistula leading to a very low risk for

the development of intracranial haemorrhage or neurological symptoms. The complete treatment of the fistula prevents further possible recurrences of venous thrombosis or a new DAVF in another or the same vessel segment. In contrast to the intervention described by Murphy [8] and colleagues, we used a soft coronary stent to re-open the transverse sinus and not a self-expanding Wallstent. Therefore, we could finish the treatment in one session and there was no need for aggressive procedures such as puncture of the jugular vein to gain access to the transverse sinus. As for prophylaxis after stent deployment in the arterial system [11], we treated the patient with a combination of aspirin and clopidogrel and stopped the oral anticoagulant therapy. Vilela and colleagues [12] reported a patient with an infantile DAVF treated by sigmoid sinus angioplasty and stent placement who was medicated with aspirin and clopidogrel after the procedure. Comparable to our case, a follow-up examination with venous Doppler ultrasonography after three months showed patency of the sigmoid sinus. Currently, there are no long-term data available on the patency of stents in the slow flow intracranial venous system. Several cases of intracranial venous stenting are reviewed in the same paper [12] discussing three cases with a clinical or radiological follow-up ranging from 2 to 12 months and in all cases the stents were still functional. In the unlikely case of a stent re-stenosis during follow-up we would still have the option to treat the patient again with angioplasty and further stent deployment to re-establish the normal venous pathways. On the other hand, the fistula is occluded and there is no cause for a cortical venous drainage.

Conclusions

We described an alternative interventional treatment of high grade DAVF with bilaterally occluded transverse sinuses. In contrast to conventional coil embolization of the transverse sinus at the fistulous segment, we re-canalized the sinus with a balloon-expanded stent, re-establishing the normal venous pathway and resulting in the total occlusion of the DAVF, a patent right transverse sinus and the complete resolution of the clinical symptoms after a three month follow-up. In our opinion, this procedure was successful because it both eliminated the venous hypertension and occluded the arteriovenous fistula. Long-term follow-up will be necessary to assess the efficacy of stent deployment in the venous system as a secure and efficient treatment option for thrombosed sinus.

References

1 Malek AM, Halbach VV et Al: Treatment of dural arteriovenous malformations and fistulas. Neurosurg Clin N Am 11: 147-162, 2000.
2 Cognard C, Gobin YP et Al: Cerebral dural arteriovenous fistulas: clinical and angiographic correlation with a revised classification of venous drainage. Radiology 194: 671-680, 1995.
3 Borden JA, Wu JK, Shucart WA: A proposed classification for spinal and cranial dural arteriovernous fistulous malformations and implications for treatment. J Neurosurg 82: 166-179, 1995.
4 Djindjian R, Merland JJ, Theron J: Superselective arteriography of the external carotid artery. New York, NY: Springer-Verlag: 606-628, 1977.
5 van Dijk JMC, ter Brugge KG et Al: Clinical course of cranial dural arteriovenous fistulas with long-term persistent cortical venous reflux. Stroke 33: 1233-1236, 2002.
6 Halbach V, Higashida R et Al: Transvenous embolization of dural fistulas involving the transverse and sigmoid sinuses. Am J Neuroradiol 10: 385-392, 1989.
7 Roy D, Raymond J: The role of transvenous embolization in the treatment of intracranial dural arteriovenous fistulas. Neurosurgery 40: 1133-1144, 1997.
8 Murphy KJ, Gailloud P et Al: Endovascular treatment of a Grade IV transverse sinus dural arteriovenous fistula by sinus recanalization, angioplasty and stent placement. Neurosurgery 46: 497-501, 2000.
9 Chaloupka JC, Mangla S, Huddle DC: Use of mechnical thrombolysis via microballoon percutaneous transluminal angioplasty for the treatment of acute dural sinus thrombosis: Case presentation and technical report. Neurosurgery 45: 650-657, 1999.
10 Malek AM, Higashida RT et Al: Endovascular recanalization with balloon angioplasty and stenting of an occluded occipital sinus for treatment of intracranial venous hypertension: Technical case report. Neurosurgery 44: 896-901, 1999.
11 Morris P: Interventional and Endovascular Therapy of the Nervous System. A Practical Guide. Springer, New York-Berlin-Heidelberg 135, 2002.
12 Vilela P, Willinsky RA, ter Brugge K: Treatment of Intracranial Venous Occlusive Disease with Sigmoid Angioplasty and Stent Placement in a Case of Infantile Multifocal Dural Arteriovenous Shunts. Interventional Neuroradiology 7: 51-60, 2001.

Werner Weber, M.D.
Department of Radiology and Neuroradiology
Alfried Krupp Krankenhaus
Alfried Krupp Street 21,
45117 Essen, Germany